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CONTRIBUTIONS TOWARD A REVISION OF THE OPHICHTHYID EELS
I. THE GENERA *CALLECHELYS* AND *BASCANICHTHYS*, WITH DESCRIPTIONS OF NEW SPECIES AND NOTES ON *MYRICHTHYS*

By Margaret Hamilton Storey

This study deals with the genera of ophichthyid eels currently known under the generic names *Callechelys* and *Bascanichthys*. These eels are rare in most collections, and of many of the forms only the type has been recorded. From a study of type specimens at hand, examination of the literature, and data supplied by various colleagues, fairly complete descriptions were compiled of the types of 23 nominal species. These accounts were compared by the usual means, and by a direct method discussed below, and the limits of the genera analyzed. Three species which, from the descriptions, are clearly not pertinent to these groups, are eliminated. The history and application of *Caecula*, *Sphagebranchus*, and *Dalophis*, genera to which many of the species under discussion have been referred, will be clarified in a forthcoming paper.

The author is especially indebted to Mr. J. R. Norman of the British Museum (Natural History), to Prof. J. Pellegrin of the Muséum National d'Histoire Naturelle, and to Dr. Leonard P. Schultz and Mr. E. D. Reid of the United States National Museum for their painstaking help in reexamining for her the types in their charge. Specimens at hand include eels from the collections of the California Academy of Sciences, examined through the courtesy of Dr. F. M. McFarland and Mr. H. Walton Clark; the Stanford Natural History Museum, where this study was made under the invaluable guidance of Dr. George S. Myers; and from Sanibel Island, Florida, where specimens were collected by Dr. Louise Merrimon Perry and the author.

The data utilized are from types or descriptions of types, the few exceptions always noted, and the non-type material was used for checking. Since such a large proportion of the known specimens are types, it has been necessary to confine myself entirely to external characters in defining genera. The data at hand, as a whole, suffice to clarify the genera, but are too incomplete, for *Bascanichthys* especially, to attempt synonymization of any species at this time.

A method for defining the genera (and at least some of the species) by a direct comparison was suggested when a series was studied to check a type. For, despite a wide variation as to length, the main body proportions for this species remained relatively constant, even those proportions involving the depth measure-

ments. Therefore, a diagrammatic outline, 400 mm. long, was drawn of the type of each species on a separate sheet of paper, utilizing the measurements and positions available, all scaled to that same length. It was hoped that such a rigidly diagrammatic expression would eliminate confusing details, thus bringing out not only the major differences and likenesses, but also possible correlations between the body proportions and other characters. Measurements often could be obtained from the original descriptions only by reconverting the proportions. Since these are often inconsistent or only approximate, comparison with the types or even with non-type material proved a valuable check. Some disagreement between the original account and the data from a recent reexamination of a type can be valid, as definite changes may occur during years in preservation; therefore, the original description can never be ignored.

The following measurements and positions were secured, and rescaled by slide-rule to the arbitrary length of 400 mm.: head length, trunk, tail, greatest body depth, gill-opening (including angle, see below), pectoral, dorsal, and anal fins, mouth, snout, eye, and nostrils. A plan of the dentition was placed beside each eel-outline.

An extended line, or transparent rule, passing from the lower and through the upper margin of the left gill-opening, is measured with a protractor with its base laid lengthwise of the fish. The resulting angle, given in degrees, is the gill-opening angle. A reading of 90° indicates a vertical opening, while 160° describes a sublongitudinal slit (see figures). The angle may be secured from a figure as well as from a specimen. Accurate readings may prove difficult in old specimens or indifferently drawn plates; also there is some intraspecific variation. Therefore, this character must be considered relative rather than absolute.

The outlines, greatly reduced, are shown in figures 2 and 3, while figure 1, composite outlines of the two groups naturally formed by the species, sums up the genera. The data are also analyzed in table 1, and in the key, which have been made as accurate as available information on type specimens permits.

I do not consider that, in this revision, the last word has been said on the classification of these eels, since it was impossible for me personally to examine a number of the species. The genera adopted may have to be broken up when one person can examine a large number of the species. But I feel that the characters disclosed by my present method of approach have indicated the true relationships in a broad way. Several of the characters provoke speculation. For example, there is a definite, though not unvarying, correlation between the gill-opening position and angle, and the absence or presence of a pectoral fin. Why is this so, and how are the exceptions explained? Why should the position of the dorsal fin origin prove an important character? And why, within these (and other) genera of world-wide distribution, should the presence and character of striking body markings, or their complete absence, have such great significance?

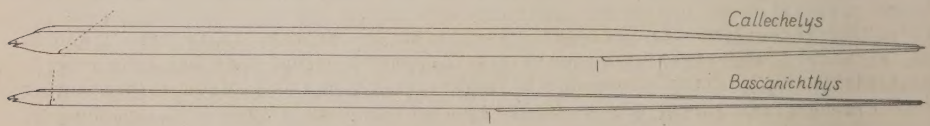

Fig. 1. Composite outlines of the type specimens of the species constituting the genera *Callechelys* and *Bascanichthys*, scaled to same total length, 400 mm. See figures 2 and 3, table 1, and the key to the genera, opposite.

KEY TO THE GENERA

Scaleless eels without fin-rays at caudal tip, but with dorsal and anal present, and extending almost to tail-tip; dorsal fin beginning on head well before gill-opening; pectorals never fully developed if present; teeth usually slender, more or less recurved, acute or blunt-tipped, never granular or molar, jaw-teeth usually uniserial; snout conical, usually acute, projecting well beyond lower jaw; no filaments on upper lip; anterior nostrils tubular, on under side of snout, posterior nostrils usually in slits, with or without flaps, on under side of upper lip, more or less under the eye, which is before the angle of the jaw.

1a. Pectorals absent; gill-openings low-lateral to almost ventral, oblique to sublongitudinal (angle of gill-opening (142.9°)[1] 115°-164°); isthmus narrower than gill-opening (isthmus in gill-opening (2.3) 1.55-3.65); head moderate (in length (16.0) 12.2-19.65); tail short (in length (2.8) 2.55-3.3), shorter than trunk (in trunk (1.65) 1.4-2.15); dorsal fin moderate to high, beginning on head above or slightly behind angle of jaw (snout-tip to dorsal fin origin in head (2.9) 1.95-3.7); premaxillary[2] and vomerine teeth usually paired (posterior vomerines may be uniserial or absent), always somewhat enlarged, sometimes canine-like; maxillary teeth usually confined to posterior 2/3 of jaw; body usually moderately heavy (depth in length (48.0) 35.7-75.0); body and usually both dorsal and anal fins strikingly marked (with longitudinal bands, marblings, splotches, or spots)..... *Callechelys*

1b. Pectorals usually present, but never fully developed (filamentous, medium wide, or broad, but always very short, about 0.5-2 in eye); gill-openings lateral or low-lateral, never almost ventral, usually almost vertical, never sharply oblique (angle of gill-opening (94.25°) 78°-116°); isthmus about equal to gill-opening; head small (in length (20.65) 17.5-23.55); tail moderate (in length (2.1) 1.9-2.4); about equal to trunk (in trunk (1.0) 0.8-1.25); dorsal fin usually low, beginning on head in advance of gill-openings, but well behind angle of jaw (snout-tip to origin of dorsal fin in head (1.8) 1.35-2.4); premaxillary and vomerine teeth variously arranged (or absent?), never notably enlarged or canine-like; maxillary teeth uniserial or partly biserial (sometimes biserial?), beginning adjacent to the first vomerines, lower jaw-teeth uniserial (except *B. scuticaris*); body usually slender (depth in length (65.4) 41.9-101.0); body never strikingly marked, usually dark above, paler below, fins usually pale..... *Bascanichthys*

GENUS *CALLECHELYS* KAUP

Callechelys Kaup, 1856a, p. 28; 1856b, p. 51 (genotype by monotypy *C. guichenoti*).

The characters for this genus are shown in the key, in figures 1 and 2, and in table 1, and agree with the original account, except that Dr. Kaup records "a solitary nasal tooth." However, Pellegrin (1912, p. 206) finds evidence that there had originally been two premaxillary teeth in Kaup's type of *C. guichenoti*.

Günther (1910, p. 404) synonymizes *Callechelys guichenoti* and *C. luteus* Snyder with *Ophichthys (Sphagebranchus) marmoratus* (Bleeker), while Weber and de Beaufort (1916, p. 288) synonymize *Callechelys luteus* with *C. marmoratus*.

[1] Arithmetic mean. Numerical and parenthetic data in key hold for type specimens only.

[2] The use of "premaxillaries" seems justified (Trewavas, 1932, p. 640).

Although the generic name is unaffected, an effort was made to settle the matter. Pellegrin, above, notes the similarities between *C. guichenoti* and *C. marmoratus*, but states that the latter has four "nasal" teeth, a longer snout, and a very different coloration. In 1938, he again reexamined the type of *C. guichenoti*, and sent me additional data, as did Mr. Norman and Dr. Schultz, for *C. marmoratus* and *C. luteus*, respectively. Thus, more complete descriptions could be set up for comparison; these are summarized in table 1 and figure 2, and need no comment.

The species in this genus tend to be separated into three groups, mainly by the gill-opening angles, the markings, the position of the dorsal fin origin, and the depth measurements. The structure of the teeth, especially, will have to be investigated before these group-differences can be shown to be generic.

Callechelys sibogae Weber (1913, p. 49, fig. 11; also in Weber and de Beaufort, 1916, p. 288, fig. 133), of which the type is unique, is excluded from this genus; for the teeth are biserial on the jaws, the snout is blunt, there are filaments on the upper lip, the gill-openings are minute and widely separated, the body is very slender, the coloration is plain, and the dorsal and anal fins end at some distance before the tail-tip. I cannot place it.

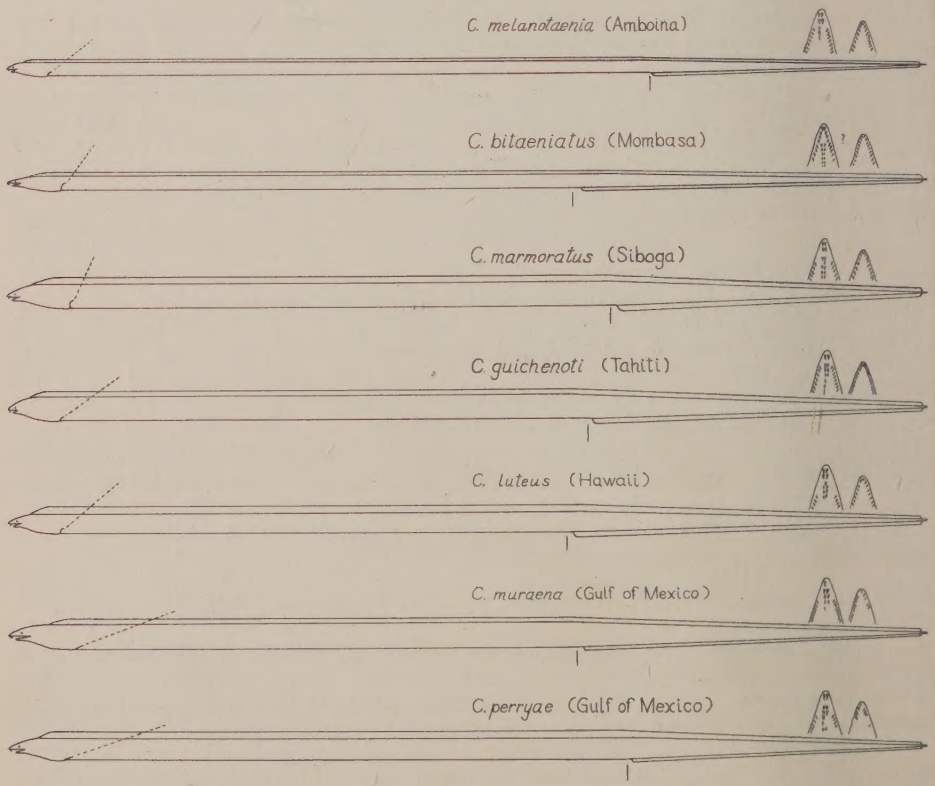

Fig. 2. Outlines of the type specimens of the species of *Callechelys*, each scaled to a length of 400 mm. See also table 1 and figure 1.

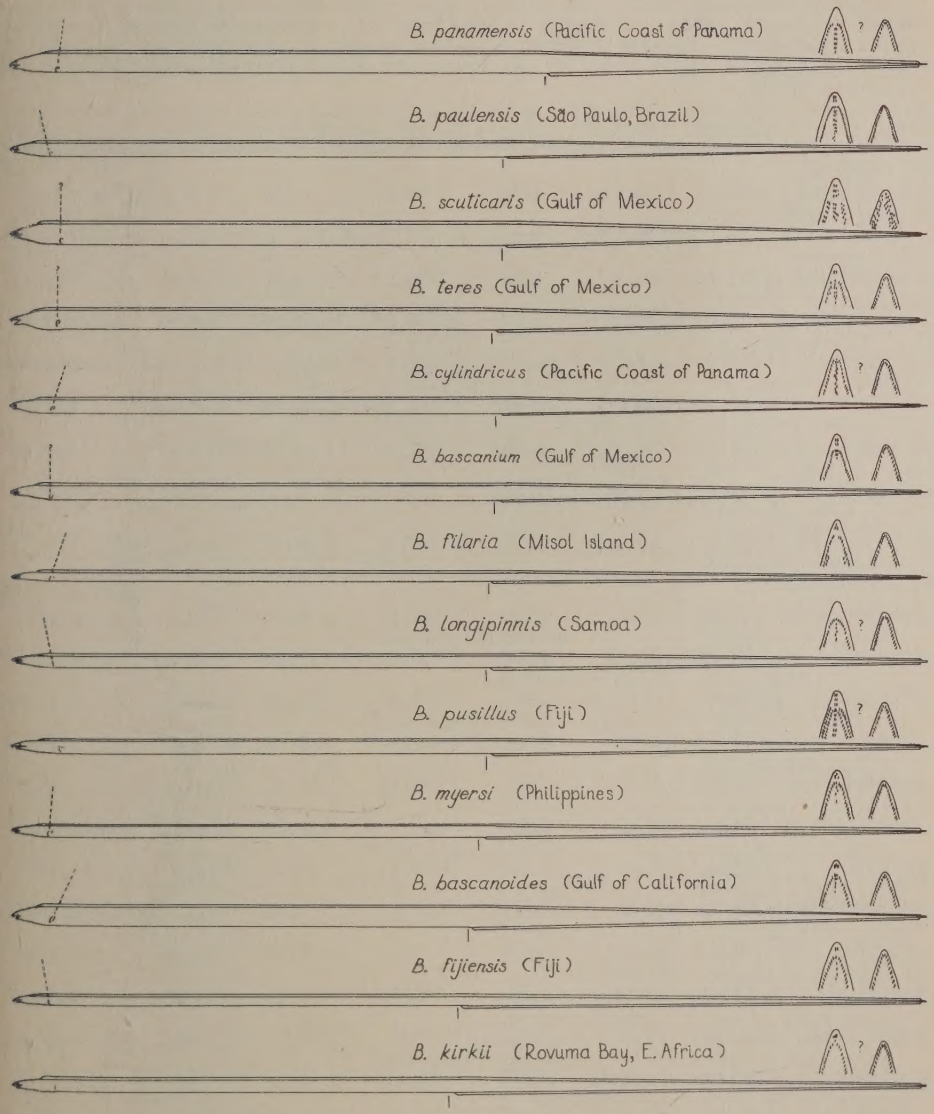
B. panamensis (Pacific Coast of Panama)
B. paulensis (São Paulo, Brazil)
B. scuticaris (Gulf of Mexico)
B. teres (Gulf of Mexico)
B. cylindricus (Pacific Coast of Panama)
B. bascanium (Gulf of Mexico)
B. filaria (Misol Island)
B. longipinnis (Samoa)
B. pusillus (Fiji)
B. myersi (Philippines)
B. bascanoides (Gulf of California)
B. fijiensis (Fiji)
B. kirkii (Rovuma Bay, E. Africa)

Fig. 3. Outlines of the type specimens of the species of *Bascanichthys*, each scaled to a length of 400 mm. See also table 1 and figure 1.

Table 1. Compared characters of the type specimens of the species of *Callechelys* and *Bascanichthys*. D=depth; L=length; H=head; Tr=trunk; Tl=tail; J=snout-tip to inner rictus of jaw. Unkeyed data=from original description;*=from plate; †=from reexamination of type by the author; ‡=from reexamination of type by others, 1936-38.

Types	D in L	H in L	Tr in L	Tl in L	H in Tr	Tl in Tr	J in H
CALLECHELYS							
melanotaenia (orig. descr.)	75.0	19.65	1.55	3.3	12.2	2.15	3.35
melanotaenia (British Mus.)	(76.0)	(15.6)†	(1.5)‡	(3.55)‡	(10.2)†	(2.35)‡	(2.9)†
bitaeniatus	60.0	16.7	1.8	2.6	8.7	1.45	3.8
marmoratus	38.3	14.1†	1.7†	2.9†	8.25†	1.7†	4.15†
guichenoti	38.9	17.5	1.75	2.7	10.0	1.55	5.25*
luteus	45.2‡	16.9†	1.8†	2.55‡	9.3†	1.4†	3.7†
muraena	35.7‡	12.2‡	1.85‡	2.6‡	6.55‡	1.4‡	3.2‡
perryae	43.1†	15.0†	1.65†	3.05†	9.05†	1.85†	3.7†
MEAN	48.0	16.0	1.75	2.8	9.15	1.65	3.9
BASCANICHTHYS							
panamensis	48.9	19.8	1.9	2.4	10.6	1.25	4.6
paulensis	67.7†	21.2†	2.0†	2.2†	10.5†	1.1†	4.6†
scuticaris	41.9	17.5	2.05	2.15	8.45	1.05	4.1
teres	45.5	18.25	2.1	2.1	8.65	1.0	4.0
cylindricus	58.5	21.2	2.05	2.15	10.55	1.05	5.1
bascanium	54.0	21.6	2.05	2.1	10.35	1.05	3.75
filaria (type, 1916)	97.0 (120.0)	21.1	2.1	2.1	10.0	1.0	4.5
longipinnis	77.1	21.0	2.1	2.1	9.95	1.0	4.5*
pusillus	67.5	18.0	2.15	2.1	8.35	.95	3.1
myersi	78.8†	22.5†	2.15†	2.05†	10.5†	.95†	5.0†
bascanoides	48.25	22.0	2.2	2.0	10.0	.9	4.4*
fijiensis (type ptly dry)	101.0†	23.55†	2.25†	1.95†	10.5†	.9†	4.3†
kirkii (see text)	64.0	20.5	2.35	1.9	8.8	.8	4.0
MEAN	65.4	20.65	2.1	2.1	9.8	1.0	4.3

Types D in L H in L Tr in L Tl in L H in Tr Tl in Tr J in H

Table 1, cont'd. Compared characters of the type specimens of the species of *Bascanichthys* and *Callechelys*. DO=snout-tip to origin of dorsal fin; H=head; Is=isthmus; GO=gill-opening; GO angle (see p. 62): 90°=vertical, 160°=sublongitudinal; Pect=pectoral fin; Post nos=posterior nostril. See page 66 for *, †, and ‡.

Types	DO in H	Is in GO	GO angle	Pect	Post nos	Markings
CALLECHELYS						
melanotaenia (orig. descr.)	2.7		147°*	none	flap	dk longi band on lt, dorsal fin margin dk
melanotaenia (British Mus.)	(2.35)‡	(1.5)‡	(105°)‡	(none)	(flap)‡	
bitaeniatus	2.7*		127°*	none		dk longi band on grn, dorsal fin margin dk
marmoratus	3.7*	2.5‡	115°‡ (96°*)	none	flap‡	yellow marblings on dk brown, body & fins
guichenoti	3.4*	1.65‡	145°‡ (121°*)	none	flap‡	dk dots, freckles on med dk, body & fins
luteus	3.15‡	1.55‡	141°‡ (134°*)	none	folded flap‡	dk & yellow mottled on white, body & fins
muraena	1.95‡	2.1‡	164°*	none	no tube‡	dk spots & mottled on olive; fins lt edged
perryae	2.7†	3.65†	161°†	none†	flap†	dk spots on dk tan; anal fin pale†
MEAN	2.9	2.3	142.85°	none	flap	striking markings on body and dorsal fin
BASCANICHTHYS						
panamensis	1.5*	1.0	98°* "vertical"	rudi, narrow		bluish above, pale below; fins pale
paulensis	2.4†	1.0†	78°†	rudi, narrow†	folded flap†	uniform ? fins pale†
scuticaris	2.05	1.0	90°* "vertical"	rudi, narrow	no tube	brownish; lighter below
teres	2.4	1.0	"vertical"	rudi		uniform dk, paler below; fins pale
cylindricus	1.75*	1.0	109°*	rudi, medium		bluish black above; below & fins pale
bascanium	1.35	1.0	90° "vertical"	rudi, medium		nearly uniform, plain; fins pale
filaria	1.7*		109°*	rudi, narrow		uniform
longipinnis	1.85*		80°*	none (rudi?)		dk punctulations; below and fins pale
pusillus	2.0	1.0		rudi	"rounded aperture"	brown above, lighter below; dors fin pale
myersi	1.6†	1.0†	95°†	rudi medium†	folded flap†	dk brown above, pale below; fins pale†
bascanoides	1.7*	1.0	116°* "vertical"	rudi, medium		dk brown above, pale below; fins pale
fijiensis (type ptly dry)	1.75†	1.0†	82°†	flap, no rays†	on papilla	dk brn & blk punctu; fins & belly pale†
kirkii (see text)	1.65			none	no tube	uniform
MEAN	1.8	1.0	94.25°	rudi	no tube	dark above, pale below, fins pale

Types DO in H Is in GO GO angle Pect Post nos Markings

Callechelys melanotaenia Bleeker

Callechelys melanotaenia Bleeker, 1864, p. 66, pl. 193, fig. 2 (Amboina), type probably in Leiden Museum, length 530 mm.; 1865, p. 1 (same descr.); Jordan and Snyder, 1901, p. 865 (descr., Riu Kiu Ids.); Weber and de Beaufort, 1916, p. 289 (descr., Leiden Mus. type?); Fowler, 1928, p. 43 (descr., Palmyra Id.).
Ophichthys melanotaenia Günther, 1870, p. 87 (descr., "type of species, 19 inches long"); 1910, p. 403 (brief descr.); Klunzinger, 1871, p. 612 (descr., Red Sea).

Dr. Bleeker's described specimen is 530 mm. long, but he does not state that it is unique. It therefore seems probable that he accidentally sent a paratype instead of the holotype to the British Museum, where a 19-in. (according to Günther), 475-mm. (according to Norman), specimen evidently has since been accepted as the type. Because its standing has not been questioned hitherto, the data from Mr. Norman's 1938 examination of the specimen are included, in parentheses, in table 1 (but not in the means), and the measurements are given below. The specimen Weber and de Beaufort examined in the Leiden Museum probably will prove to be the holotype.

Mr. Norman, in 1938, reports of the British Museum specimen: length 475 mm.; head 30.5; trunk 311.5; tail 133; gill-opening 3, gill-opening angle as sketched by him 105°; isthmus 2; snout-tip to inner rictus of jaw 10.5; snout-tip to origin of dorsal fin 13; posterior nostril below eye, covered with flap; 3 premaxillary teeth, 1 pair vomerines (no posterior vomerines), maxillary teeth uniserial, beginning behind the vomerines; "specimen rather soft and imperfectly preserved."

Fowler gives a depth in length proportion of 37; this must be a typographical error, as 73, for instance, would be in accord with the other records.

The specimen described by Jordan and Snyder is in the Stanford Natural History Museum Collection, and is in splendid condition. The expanded bases of the teeth show well. The posterior nostrils are covered with a backwardly directed flap, folded to appear tube-like. There is no evidence of pectoral fins. The specimen is close to the type description in all characters. The gill-opening angle is 125° (Bleeker's plate shows 147°).

Callechelys bitaeniatus (Peters)

Ophichthys bitaeniatus Peters, 1878, p. 556, figs. 2 and 2a (Mombasa, East Africa), type probably in Berlin, length 300 mm.

The plan of the dentition in the original plate is probably inaccurately drawn (see my fig. 2). Evidently the type is unique. This species needs further study; for, though it is separated by good specific characters from *Callechelys melanotaenia*, the two together present suggestive evidence that a new genus may be needed for them.

Callechelys marmoratus (Bleeker)

Dalophis marmorata Bleeker, 1853, p. 37 (Siboga), type in British Museum, length 868 mm.; 1854, p. 100 (same descr.).

Sphagebranchus ? marmoratus Kaup, 1856a, p. 26 (brief descr.).
Sphagebranchus marmoratus Kaup, 1856b, p. 51 (name only); Bleeker, 1859, p. 174 (name only).
Callechelys marmoratus Bleeker, 1864, p. 66, pl. 155, fig. 2 (descr.); Weber and de Beaufort, 1916, p. 288, fig. 132 (excluding *luteus* in synonymy; descr., type, Mauritius, Pelew Ids.).
Ophichthys marmoratus Günther, 1870, p. 88 (brief descr., type); 1910, p. 404 (excluding *luteus* and *guichenoti* in synonymy; brief descr., Mauritius).

Mr. Norman, in 1938, reports of the type: length 873 mm.; head 62; trunk 511; tail 300; gill-opening about 10, angle of gill-opening as sketched by him 115°; isthmus about 4; snout-tip to inner rictus of jaw about 15; dorsal origin measurement unobtainable; posterior nostril on under side of upper lip, just in advance of eye, covered with flap; "specimen rather soft and imperfectly preserved." See my figure 2 for his plan of the dentition.

See note in *C. luteus* below for Fowler's report from the Galapagos.

Callechelys guichenoti Kaup

Callechelys guichenoti Kaup, 1856a, p. 28, pl. 3, fig. 13 (Tahiti), type in Paris M.N.H.N., No. 2126, length 18.7 in.; 1856b, p. 52 (same descr., length 475 mm.; Pellegrin, 1912, p. 206 (redescr. type, length 458 mm., and New Hebrides).

Professor Pellegrin, in 1938, reports of the type: "longueur rectifiée" 468 mm.; gill-opening 5, gill-opening angle as drawn by him 145°; isthmus 3; posterior nostril under anterior margin of eye, with flap. His plan of the dentition is shown in figure 2.

Callechelys luteus Snyder

Callechelys luteus Snyder, 1904, p. 517, pl. 3, fig. 5 (Molokai, T.H.), type in U.S.N.M., No. 50864, length 83 cm.; Jordan and Evermann, 1905, p. 86, pl. 8, fig. 1 (same descr.); Jordan and Seale, 1906, p. 194 (name only); Jordan and Jordan, 1922, p. 15 (name only).
Callechelys marmoratus Fowler, 1928, p. 43 (nec Bleeker; brief descr., Honolulu).

Dr. Schultz, in 1938, reports of the type: length 811 mm.; head 48; trunk 445; tail 318; greatest body depth 18, at about 25 mm. behind the gill-openings; snout-tip to inner rictus of jaw 13; snout-tip to origin of dorsal fin 15.3; gill-opening 6.6, gill-opening angle as sketched by him 141°; isthmus 4.2; posterior nostril under anterior edge of pupil, "covered with a flap which is folded slightly to give the appearance of a rather large tube." His plan of the dentition is shown in figure 2.

Possibly Fowler's (1932, p. 3) record of a 310-mm. specimen of *C. marmoratus* from the Galapagos Islands is of this species.

Callechelys muraena Jordan and Evermann

Callechelys muraena Jordan and Evermann, 1886, p. 466 (Snapper Banks, Gulf of Mexico), type in U.S.N.M., No. 37996, length 13 in.; Jordan 1887b, p. 606 (name only); Jordan and Davis, 1892, p. 620, pl. 77 (keyed descr., note, type);

Jordan and Evermann, 1896, p. 378 (descr.); 1900, pl. 63, fig. 164; Evermann and Kendall, 1900, p. 53 (locality and references); Breder, 1929, p. 53, 54 (keyed and mentioned); Jordan, Evermann and Clark, 1930, p. 86 (name only).

Since original and subsequent descriptions and the plate of the unique type differ somewhat, the species is here redescribed with additional data from Mr. E. D. Reid's reexamination of the type in 1936. Pertinent original data are included. Certain changes may be due to preservation, therefore characters previously given, which disagree with the present account, are noted at the end.

Head in length 12.2; depth at gill-opening in length 35; depth at midsection of trunk in length 35.7; trunk in length 1.85; tail in length 2.6; snout-tip to origin of dorsal fin in length 23.9; width in depth at midsection of trunk 1.5; head in trunk 6.55; tail in trunk 1.4; depth at midsection of trunk in head 2.9. Eye in head 14.8; snout in head 7; snout-tip to inner rictus of jaw in head 3.2; snout-tip to origin of dorsal fin in head 1.95. Eye in snout 2.15. Eye half way between snout-tip and inner rictus of jaw. Nostrils labial, the anterior in a short tube, the posterior without tube, placed under the anterior edge of eye. Teeth acute, blunt-tipped, those on jaws small and uniserial, 9 or 10 on each side of the posterior half of upper jaw, about 15 on each side of lower jaw, ranged from jaw-tip to rictus, a little larger anteriorly. A single canine-like tooth at left on premaxillary (right one lost?), and about 8 smaller but enlarged teeth on vomer, the first six the largest, and biserial. All the larger teeth directed more or less backwards. Gill-openings inferior, sublongitudinal, plate shows a gill-opening angle of 164°. Isthmus in gill-opening 2.1. "Body stouter and more compressed than in other species of this group. Dorsal fin rather high, beginning on head at a distance behind the angle of the mouth a little more than half the length of the upper jaw. Anal well developed but lower than the corresponding parts of the dorsal. Tail projecting behind dorsal and anal. No trace of pectoral fin.

"Color olive, closely mottled and spotted with confluent blotches of dark olive and blackish, the spots most distinct anteriorly, posteriorly confluent so that the tail is nearly plain dusky. Belly scarcely paler. No black around gill-opening. Dorsal and anal chiefly blackish, each with a conspicuous, narrow, pale margin." Quotation is from the original description.

A single specimen, 13 in. long (325 mm. in 1936), taken in 1886 by Mr. Silas Stearns from the "spewings" of a food-fish from the Snapper Banks, in the Gulf of Mexico, somewhere off Pensacola, Florida.

Mr. Reid, in 1936, reports of the type: length 325 mm.; head 26.6; tail 124; snout-tip to inner rictus of jaw 8.4; snout-tip to origin of dorsal fin 13.6; eye 1.8; snout 3.8; gill-opening 4.2; isthmus 2.0; depth at gill-opening 9.3; depth at middle of trunk 9.1; width at middle of trunk 6.1. Mr. Reid also sent me clay impressions of the dentition, sketched in figure 2, page 64.

Comparing type with plate, Mr. Reid reports: "The plate as a whole is a fairly good representation of the type. The posterior part of the trunk and the caudal portion is darker in the type, and the snout as shown in the plate is more decurved, especially in front of the eyes, than is the case with the specimen."

Jordan and Evermann originally give the proportions head in length 13, head in trunk 7; and describe the teeth as more or less bluntly conical, the posterior nostril as just before front of eye, and the gill-opening as small, somewhat oblique. But Jordan and Davis give for the type, head in length about 14, head in trunk 8, and describe the gill-openings as inferior, sublongitudinal.

Callechelys perryae, sp. nov.

(Fig. 2, p. 64, and fig. 4, p. 73.)

Head in length 15; greatest depth, at anterior sixth of trunk, in length 43.1; depth at gill-opening in length 49.0; depth at midsection of trunk in length 52; trunk in length 1.65; tail in length 3.05; snout-tip to origin of dorsal fin in length 40.7. Width in depth at midsection of trunk 1.2. Depth at gill-opening in head 3.25; greatest depth in head 2.9. Eye in head 21.3; snout in head 7.5; snout-tip to inner rictus of jaw in head 3.7; snout-tip to origin of dorsal fin in head 2.7; eye in snout 2.9. Angle of gill-opening 161°; isthmus in gill-opening 3.65. Dorsal fin height in greatest body depth 3.6, in depth at midsection of trunk 3.0. Eye just anterior to midpoint between snout-tip and inner rictus of jaw, and above anterior third of lower jaw. Anterior nostrils on under side of snout, in tubes shorter than eye-width, posterior nostrils on inner under side of upper lip, under anterior third of eye, covered with flap. All teeth more or less depressible, slender, blunt-tipped, slightly to greatly recurved. Jaw-teeth small, uniserial, 5 or 6 on each side of upper jaw, confined to posterior half, and perhaps 8-12 on each side of the lower jaw (most are missing). A pair of canine-like premaxillary teeth, their length equal to eye; 8 vomerines, separated by a space from the premaxillaries, mostly biserial, the largest smaller than the premaxillaries. Gill-openings almost ventral, sublongitudinal; isthmus very narrow. Eye covered by membrane. Body little compressed. Dorsal fin beginning a little behind angle of jaw. Anal developed but low. Tail-tip finless. No trace of pectoral fins. For outline of head, see figure 4, page 73.

Color in preservative: snout a medium pinkish tan, without markings; head posterior to eye covered with small (2 mm.), dark, oval spots, increasing in size toward the gill-openings to about 5 mm., becoming less abundant ventrad. Body dark tan above, lighter below; entire dorsum to just below midline covered with a mass of oval spots, composed of a few small (2.5 mm.), and many medium (5.5 mm.) and large (8.5 mm.) ones, sometimes confluent; the dorsal pattern remaining uniform the length of the fish; on the belly anteriorly the spots are small, sparsely scattered, disappearing in the midsection, and reappearing again posterior to anus, where they gradually increase in number and diversity of size, assuming the dorsal pattern, so that the last quarter of the tail is uniformly marked throughout. Dorsal fin covered with medium and large blotches on a whitish ground, which last is strikingly apparent at irregular intervals along the margin of the fin. Anal pale, without markings.

One specimen, Stanford N.H.M. Coll. No. 33027, 734 mm. long, caught by the author bait-fishing with cut bait in the Gulf of Mexico, a mile off the southern shore of Sanibel Island, Florida, in 2-3 fathoms, mud and broken shell bottom, in June, 1935. Initial preservative 5% formaldehyde, transferred to 75% alcohol, September, 1935. The above description is based on measurements taken in 1938: length 734 mm.; head 49; trunk 444; tail 241; greatest depth, at anterior sixth of trunk, 17.0; depth at gill-opening 15; depth at midpoint of trunk 14.1; snout-tip to inner rictus of jaw 13.2; snout-tip to origin of dorsal fin 18; snout 6.7; eye 2.3; gill-opening 8; isthmus 2.2; gill-opening angle 161°; dorsal fin height 4.7. For plan of dentition see figure 2, page 64.

Named in honor of Dr. Louise Merrimon Perry, physician and naturalist.

This species can be compared only with *C. muraena*, from which it differs

in all proportions. Size alone cannot account for these differences, as has been shown elsewhere in this paper. Of particular note are the position of the dorsal fin origin, the distance between the gill-openings, the proportions involving eye, head, trunk, and tail, and the markings, especially of the under parts and the anal fin. Together these two western Atlantic species are apparently separated from the other members of the genus by the gill-opening angle of about 160°, as compared with 115°-147°.

GENUS *BASCANICHTHYS* JORDAN AND DAVIS

Bascanichthys Jordan and Davis, 1892, p. 621 (genotype by original designation *Caecula bascanium* Jordan).

The characters for this genus are shown in the key, in figures 1 and 3, and in table 1. They agree with the original account, except that, all other characters being present, eels with vertical bands or other markings on the head, if the body coloration is plain, also those apparently lacking pectoral fins, are included. A vestigial pectoral is easily overlooked, or may be present on one side only, as will be shown later. The gill-opening angle proves a far more reliable character, apparently correlated in some measure with the absence or presence of pectoral fins.

The series of figures, especially, show clearly the immediately apparent differences between the two genera. Although certain of the characters given seem to overlap somewhat (see table 1), I do not think they do actually, in most cases. Although there are several characters, each of which could be relied upon to separate the two groups, I am of the opinion that it is the compound evidence of a number of characters that should hold, rather than any one of them, even if absolute. I believe that these two genera, as I recognize them, are perfectly distinct and definable entities.

Since the original descriptions seemed adequate for the generic placement of these species, the type specimens were not traced and reexamined in all cases; therefore, no attempt can be made to synonymize possibly nominal species.

Bascanichthys scuticaris and *B. pusillus*, each apparently represented by an unique type specimen, are included with some misgivings, for truly biserial jaw-teeth may reflect osteological characters of generic significance.

Günther (1870, p. 88) describes most briefly *Ophichthys tenuis*, locality unknown, length 21 in., from several specimens in the British Museum. According to Günther, Kaup erroneously had placed them with *Lamnostoma bicolor*. The nontubular anterior nostril and the very large head apparently exclude the species, here noted only because Günther places it between two species of this genus.

Bascanichthys panamensis Meek and Hildebrand

Bascanichthys panamensis Meek and Hildebrand, 1923, p. 151, pl. 7 (Chame Point, Pacific coast of Panama), type in U.S.N.M., No. 82211, length 735 mm.

Meek and Hildebrand had 115 specimens, 155-735 mm. long. Premaxillary teeth and posterior nostrils are not described. I cannot make text and plate agree.

Bascanichthys paulensis, sp. nov.

(Fig. 3, p. 65, and fig. 5, p. 73.)

Head in length 21.2; depth in length 67.7; trunk in length 2.0; tail in length 2.2; head in trunk 10.5; tail in trunk 1.1; snout-tip to origin of dorsal fin in head 2.4; snout-tip to inner rictus of jaw in head 4.6; eye in head 30.2; snout in head 7.75; eye in snout 3.9; pectorals about 2.15 in snout, narrow, extending from upper edge of gill-openings, which are low-lateral, semilunar, with a gill-opening angle of 78°; gill-opening in head 10.05; isthmus in gill-opening 1.0; dorsal fin height in body depth 3.7; anal about half dorsal height; dorsal and anal extending almost to tail-tip. Anterior nostrils in low, broad tubes, on under side of snout, just in advance of tip of lower jaw; posterior nostrils covered with backwardly directed flaps, folded tube-like, on the under side of upper lip, below anterior margin of eye. Teeth small, slender, blunt-tipped, recurved; uniserial on jaws; 4 irregularly paired premaxillary teeth, slightly enlarged, and separated by a space from the 26 smaller vomerines, which are irregularly bi- and triserial anteriorly, becoming smaller and uniserial posteriorly. About 20 teeth on each side of the upper jaw, and 18 or 19 on each side of the lower jaw, slightly larger anteriorly. See figure 3, page 65, and figure 5 below.

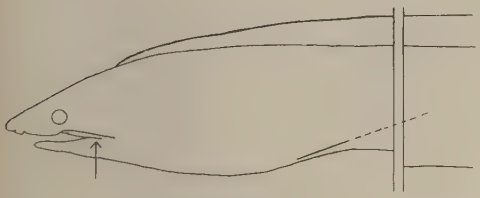

Fig. 4. *Callechelys perryae*, sp. nov. See page 71 for description.

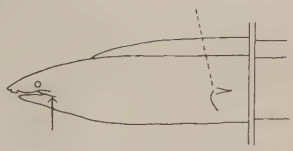

Fig. 5. *Bascanichthys paulensis*, sp. nov.

No markings or color noted on the almost cylindrical body, or on the fins.

One specimen, California Academy of Sciences Coll. No. 5586 ("Do Amaral Ac. 66 'Ciudado' São Paulo"), probably taken from the stomach of a larger fish; for, although the present state of preservation is good, it is evident that the eel had been partly digested when found. The 1938 measurements are: length 642.2 mm.; head 30.2; trunk 317; tail 295: greatest body depth, at gill-opening, 9.5; snout 3.9; eye 1.0; snout-tip to inner rictus of jaw 6.6; snout-tip to origin of dorsal fin 12.5; gill-opening 3; gill-opening angle 78°; isthmus 3; pectoral filaments 1.8; dorsal fin height 2.5; anal height about half dorsal height.

This species differs from all others in the genus, except *B. teres*, in the advanced position of the dorsal fin origin; and from that species in the smaller head and mouth, the gill-opening angle, the dentition, and the more slender body. *B. paulensis* alone excepted, the species in the Western Hemisphere have heavier bodies (depth in length less than 60) than those of the Eastern Hemisphere (depth in length over 60). See figure 3, page 65.

Apparently this is the first South Atlantic record for the genus.

Bascanichthys scuticaris (Goode and Bean)

Sphagebranchus scuticaris Goode and Bean, 1880, p. 343 (Cedar Key, Fla.), type in U.S.N.M., No. 23636, length 750 mm.; ?Garman, 1896, p. 93 (note, Key West).
Caecula scuticaris Jordan and Gilbert, 1882c, p. 358 (descr. copied); ?Jordan, 1885b, p. 42 (brief descr., Egmont Key, Fla., note).
Callechelys scuticaris Jordan, 1885a, p. 52 (name only; 1887a, p. 840, same paper); 1887b, p. 606 (name only).
Bascanichthys scuticaris (part) Jordan and Davis, 1892, p. 621 (synonymize *S. teres*; keyed and mentioned, ?Egmont Key, ?Punta Rassa, ?Pensacola, Fla.); Jordan and Evermann, 1896, p. 378 (descr. compiled); 1900, pl. 63, fig. 165 (of *B. teres*?); Evermann and Kendall, 1900, p. 53 (localities and references); Breder, 1929, p. 53, 54 (keyed and mentioned); Jordan, Evermann and Clark, 1930, p. 86 (name only).

It is evident that the dentition of the type (which may be unique) has never been critically reexamined. Goode and Bean state, and clay impressions of the teeth of the type made for me by Dr. Schultz show, that the teeth are biserial on both jaws and vomer (the impression suggests irregular triseriality, see figure 3). Yet in every recent description, beginning with Jordan and Davis, the teeth are called uniserial on the jaws, biserial on the vomer. I can find no certain record for this species, except for the type. Most specimens heretofore referred to it will certainly have to be placed with *B. teres*. The only published figure may have been made from the type.

It is a question whether any species with such strongly banded teeth can be included in this genus, for it presupposes a different maxillary architecture. A careful reexamination of the type, and a search for more specimens are needed.

Bascanichthys teres (Goode and Bean)

Sphagebranchus teres Goode and Bean, 1882, p. 436 (West Florida), types in U.S.N.M., No. 31457, 3 specimens, lengths 18.5-21.8 in.
Caecula teres Jordan and Gilbert, 1882c, p. 897 (descr. copied?); ?Jordan, 1885b, p. 42 (note, Egmont Key, Fla.).
Callechelys teres Jordan, 1885a, p. 52 (name only; 1887a, p. 840, same paper); 1887b, p. 606 (name only).
Bascanichthys scuticaris (part) Jordan and Davis, 1892, p. 621 (*S. teres* synonymized; keyed and mentioned, Egmont key, Punta Rassa, Pensacola, Fla.); Jordan and Evermann, 1896, p. 378 (descr. compiled); 1900, pl. 63, fig. 165 (possibly of *B. teres*); Evermann and Kendall, 1900, p. 53 (localities, references); Breder, 1929, p. 53, 54 (keyed and mentioned); Jordan, Evermann and Clark, 1930, p. 86 (name only).

Goode and Bean's erroneous assertion that the jaw-teeth of the three types are "in moderate bands" partly explains but does not excuse the half century this species has remained in synonymy. To make the confusion complete, recent descriptions of the (combined) species have ignored both original accounts by stating that the jaw-teeth are uniserial. As has been shown, the type of *B. scuticaris* has bi- if not triserial teeth. Dr. Schultz also made impressions of the teeth of all three types of *B. teres* for me, which show the jaw-teeth to be uniserial,

with a suggestion of irregular biseriality on one side of the upper jaw of one specimen (see fig. 3). This was noted by Jordan and Davis in a footnote.

A blackened and broken specimen in the California Academy Collection (from the old Indiana Collection), labeled "*Callechelys scuticaris*, Egmont Key," as well as a 201.5-mm. eel in my collection from Sanibel Island, Florida, show the jaw-teeth to be uniserial, and biserial on the vomer. The latter specimen has been cleared and stained, and will be reported upon in detail later. The maxillary bones seem too slender to accommodate bands of teeth, even with increase in size and age. The pectoral fin is a flap, without visible rays.

From available records and specimens, it would seem that most, if not all, specimens heretofore referred to *Bascanichthys scuticaris* will prove, by the dentition, the advanced position of the dorsal fin origin, and possibly by the head markings, etc., to belong to *B. teres*, a not uncommon species.

Bascanichthys cylindricus Meek and Hildebrand

Bascanichthys cylindricus Meek and Hildebrand, 1923, p. 152, pl. 8, fig. 1 (Chame Point, Pacific coast of Panama), type in U.S.N.M., No. 82210, length 785 mm.

Described from 10 specimens, 235-865 mm. long. Premaxillary teeth and posterior nostrils are not mentioned. I could not make text and figures agree.

Bascanichthys bascanium (Jordan)

Caecula bascanium Jordan, 1885b, p. 43 (Egmont Key, Florida), type, Yale College Register No. 826, believed lost, length 31 in.

Callechelys bascanium Jordan, 1885a, p. 52 (descr. copied, note; 1887a, p. 840, same paper); 1887b, p. 606 (name only).

Bascanichthys bascanium Jordan and Davis, 1892, p. 621 (established as genotype; keyed and mentioned); Jordan and Evermann, 1896, p. 379 (descr. copied); Evermann and Kendall, 1900, p. 53 (localities and references); Breder, 1929, p. 53, 54 (keyed and mentioned); Jordan, Evermann and Clark, 1930, p. 86 (name only).

Dr. A. E. Parr has made a careful search at the Peabody Museum of Yale University for the unique type of this species, upon which the genus is based, and writes me, April 4, 1938, that he believes it lost. Apparently it has never been figured. The original length was probably about 778 mm.

Bascanichthys filaria (Günther)

Ophichthys filaria Günther, 1872, p. 425 (Misol Island), type in British Museum, length 24 in.; 1873, p. 428, pl. 33, fig. A (descr. copied); 1910, p. 404, (brief descr., Samoa).

Callechelys filaris Jordan and Seale, 1906, p. 194 (name only, lapsus).

Callechelys filaria Weber and de Beaufort, 1916, p. 290 (descr., saw type); ?Fowler, 1928, p. 43 (brief descr., Viti); 1931, p. 316 (name only).

Weber and de Beaufort, before 1916, reexamined the type, and found the hindermost maxillary teeth biserial, and three teeth on the "intermaxillary plate," and give a depth in length proportion of about 120. This last suggests considerable desiccation. Fowler reports the maxillary teeth biserial, but I question this.

Bascanichthys longipinnis (Kner and Steindachner)

Sphagebranchus longipinnis Kner and Steindachner, 1866, p. 390, pl. 5, fig. 14 (Samoa), type originally in Mus. Godeffroy, cat. nr. 2088, present whereabouts unknown, length 18" 3"'.
Ophichthys longipinnis Günther, 1870, p. 88 (brief descr., one of the types); 1910, p. 404 (brief descr.).
Dalophis longipinnis Jordan and Seale, 1906, p. 194 (brief note, Apia).
Caecula longipinne Fowler, 1928, p. 46 (brief note, Upolu); 1931, p. 316 (name only); ?Herre, 1936, p. 39 (descr. post-larva, Fiji).
?Callechelys longipinnis Deraniyagala, 1931, p. 133 (descr., Ceylon).
?Callechelys fijiensis Seale, 1935, p. 342, pl. 20, fig. 2 (part, two paratypes, Suva).

Kner and Steindachner's "line" is taken to equal .08333 inches.

Deraniyagala found no teeth on the "intermaxillary plate"; on one specimen he found a rudimentary pectoral filament on one side only. The specimen he describes is possibly not of this species, but is surely congeneric; therefore his observation on the pectoral fin is most valuable. The specimen, with trunk a little longer than tail, is 889 mm. long, nearly twice the type; the body is heavier proportionally, the jaw shorter, and the dorsal origin farther forward.

Two specimens from the California Academy, originally recorded as paratypes of *Callechelys fijiensis* and individually untagged, are referred tentatively to this species. Although small (346 and 299 mm.), and partly desiccated, they agree with the original description in all proportions, except those involving depth, and there is little doubt of their identity. The teeth are uniserial on jaws and vomer, and there is evidence of four paired premaxillary teeth. Careful inspection reveals a flap of skin, with no visible rays, immediately behind each gill-opening. This flap begins at the upper margin of the gill-opening, and extends down and slightly back, about 2/3 of the gill-opening width. This might be a pectoral fin. The gill-openings are semilunar, low-lateral, with the gill-opening angle about 85°. The posterior nostrils are under the anterior margin of the eye, on the under side of the upper lip, and are covered with a backwardly directed flap, folded to appear tube-like. The snout is conical, but the tip is not acutely pointed, or blackish, as in *Bascanichthys fijiensis*. The upper parts of the body and head are uniformly covered with fine, dark brown (but not blackish) punctulations, the lower parts and the fins are pale.

Chen (1929, p. 25, fig. 12) describes as *Sphagebranchus longipinnis* a specimen from Kwangtung, with dorsal fin origin above the gill-opening, a large head, and a tail considerably longer than the trunk. It is not of this genus.

Bascanichthys pusillus Seale

Bascanichthys pusillus Seale, 1917, p. 81 (Fiji), type in Mus. Comp. Zool., No. 25,147, length ?540 mm.; Whitley, 1927, p. 4 (name only).

Both 450 and 540 mm. are given for the length; I cannot make his proportions agree with his measurements, or with each other. For table 1, I have used the 540-mm. length, and 250 mm. for trunk only, rather than for head and trunk, as given in the description, as the only solution short of a much-needed re-

examination of the type. If, as stated in the description, truly biserial teeth are present in the upper jaw, the generic standing of the species must be carefully investigated.

Fowler (1931, p. 316) synonymizes this species with *B. filaria*.

Bascanichthys myersi (Herre)

Callechelys myersi Herre, 1932, p. 139 (Dumaguete, P. I.), type in Stanford N. H.M., No. 26828, length 788 mm.

The splendidly preserved type has uniserial vomerine teeth; the body is not banded, but uniformly covered above with fine, dark brown punctulations, and belly and fins are pale. The present proportions of the type are shown in table 1. The vertical bands on head and the small, flap-like pectorals are evident.

Bascanichthys bascanoides Osburn and Nichols

Bascanichthys bascanoides Osburn and Nichols, 1916, p. 147, fig. 4 (off San Cristobal Bay, Lower California, from stomach of *Mycteroperca venadorum*), type originally in Am. Mus. Nat. Hist., No. 5201, now in U.S.N.M., length 30 in.

Bascanichthys fijiensis (Seale)

Callechelys fijiensis Seale, 1935, p. 342, pl. 20, fig. 2 (Suva, Fiji), holotype and one paratype in Calif. Acad. Sci., holotype, No. 5500, length 350 mm., see below; paratype, No. 5501.

The four specimens in the type bottle were individually untagged, and were of two species. Two specimens are referred to *B. longipinnis*, which see. I chose the larger of the two remaining specimens for the holotype, since none in the bottle had the length measurement of the original account. Upon comparing the two types with the description and figure, redescription seemed desirable. The rather considerable desiccation affects the depth measurements, so, although the account below, and data in table 1, are made from the types in their present condition, the depth datum used in figure 3 (p. 65) is taken from the original description.

Depth in length, holotype 101.0, paratype 129.0; head in length 23.55, 24.5; trunk in length 2.25, 2.25; tail in length 1.95, 1.95; head in trunk 10.5, 10.75; tail in trunk 0.9, 0.85; snout-tip to inner rictus of jaw in head 4.3, 4.05; snout-tip to origin of dorsal fin in head 1.75, 1.55; head depth in head 3.5, 4.05; snout in head 9.4, 8.35; eye in snout 1.75, 1.7; isthmus in gill-opening 1.0, 1.0; gill-openings low-lateral, semilunar, gill-opening angle 82°, 77°. Snout conical, acutely pointed at tip; anterior nostril tubular, posterior nostril on small papilla, not tubular. Dorsal fin low, not in groove, anal fin lower, in groove. Tail-tip finless. A flap of skin, without rays, extends down and back from the upper margin of the gill-opening, its breadth about half that of the gill-opening, its length far less than 1 mm. This could be a pectoral. Teeth acute, recurved, uniserial on jaws and vomer; one pair of slightly enlarged premaxillary teeth, separated by a space from the vomerines (see fig. 3, p. 65). Body with uniform dark brown punctulations above, belly and fins pale. Head with blackish punctulations above, densest on snout, which appears quite dusky.

The 1938 measurements were taken with round-tipped compass and rule gradu-

ated to 1.0 mm. only, so smaller measurements are approximate. Data for holotype are given first. Length 353.5, 348.0; head 15, 14.2; trunk 158, 153; tail 180, 180; depth 3.5, 2.7; snout-tip to origin of dorsal fin 9.25, 9.2; snout-tip to inner rictus of jaw 3.5, 3.5; head depth 4.7, 3.5; eye 1.0, 1.0; snout 1.75, 1.7; gill-opening 1.5, 1.5; gill-opening angle 82°, 77°; isthmus 1.5, 1.5. Dorsal height less than 1.0, 1.0; anal fin lower.

This species differs from all species of the genus in the structure of the posterior nostril; from all Pacific forms in the advanced position of the dorsal origin; from all but *B. kirkii* in the long tail, from all but *B. longipinnis* and *B. paulensis* in the gill-opening angle. It also differs from *B. longipinnis* in the smaller head, and probably in the acute and blackish snout-tip.

Bascanichthys kirkii (Günther)

Ophichthys kirkii Günther, 1870, p. 89 (Rovuma Bay, on boundary between Tanganyika Territory and Mozambique), type in British Museum, several specimens, length 14 in.; 1872, p. 425 (note).
?Callechelys kirki Deraniyagala, 1931, p. 133 (descr., Ceylon).

Günther's description is most incomplete; Deraniyagala's characters are apparently in some disagreement with it, as well as with his own measurements, so were not used as a check. Thus, the data in figure 3 and table 1 are approximate.

GENUS *MYRICHTHYS* GIRARD

Myrichthys Girard, 1859, p. 58 (genotype by monotypy *M. tigrinus* Girard); Jordan and Davis, 1892, p. 616.

A preliminary review of this genus suggests that Girard's definition needs little clarification. Indeed, by including his account of the type species, a fairly workable description results. Girard evidently mistook two enlarged head pores for nostrils, overlooking the posterior nostrils. As is usual in these genera, the anterior nostrils are tubular, situated on the under side of the snout, and the posterior nostrils are not tubular, and are on the under side of the upper lip, more or less under the eye. In all species descriptions I have seen, and in all specimens at hand, a large head, short trunk, very long tail, and a moderate to heavy body are indicated, and the following proportions hold: head in trunk less than 4 to no more than 6; head and trunk not nearly equal to tail; and body depth 22-60 in length. It is probable that the depth in length is never as great as 60, for I find but two accounts of such slender specimens; both Klunzinger's (1871, p. 611) specimen of *M. maculosus* (Cuvier) and Jordan and Gilbert's (1882c, p. 899) specimen of *Pisoodonophis longus* (Poey), later synonymized with *Myrichthys acuminatus* (Gronow), may well have become desiccated before examination. Other accounts give depth in length proportions varying from 35-47 for these two species, while a very small (221.5 mm.) specimen at hand of the latter species is only 31.6. Probably no member of this genus should be characterized as "extremely elongate" without careful investigation. Apparently, in all the species, the bodies are strikingly spotted.

Weber and de Beaufort (1916, p. 285) make *Chlevastes* Jordan and Snyder (1901, p. 867, genotype *Muraena colubrina* Boddaert, which Fowler (1938, p. 118,

et ante) and others have mistakenly placed in *Myrichthys*) a subgenus of *Myrichthys*, apparently without justification. For not only do the dorsal and anal fins end well before the tip of the tail (the character commonly used to separate the two genera), but all descriptions and specimens at hand show that the main body proportions vary considerably from those for *Myrichthys*. For instance, head in trunk, for *Chlevastes*, is 7 or more, and head and trunk nearly equal tail. Also, the anterior part of the head appears notably blunt, and the body is strikingly ringed with bands, with any spots apparently incidental to the pattern. Deraniyagala's reference (1931, p. 133) to the definition of *Callechelys* applying equally to *Chlevastes* is evidently due to a misapprehension.

Myrichthys tigrinus Girard

Myrichthys tigrinus Girard, 1859, p. 58 (Adair Bay, Oregon), type in U.S.N.M., No. 8810, length 24 in.; Jordan and Gilbert, 1882c, p. 360 (descr. copied); Jordan and Davis, 1892, p. 617, 618 (keyed and mentioned, Gulf of Calif.); Jordan and Evermann, 1896, p. 376 (descr. compiled); 1900, pl. 61, fig. 161; Gilbert and Starks, 1904, p. 35 (brief descr., Panama); Osburn and Nichols, 1916, p. 147 (name only, Pichilinque Bay, Gulf of Calif.); Meek and Hildebrand, 1923, p. 149 (descr., Chame Point, Panama), Jordan, Evermann and Clark, 1930, p. 85 (name only).

Ophisurus xysturus Jordan and Gilbert, 1882a, p. 346 (Mazatlan), types in U.S.N.M., Nos. 28142, 28247, 29642, lengths 1-2 feet.

Pisodontophis xysturus Jordan and Gilbert, 1882b, p. 106 (name only).

Ophichthys xysturus Jordan, 1885c, p. 369 (name, Mazatlan, Acapulco, Panama).

Callechelys peninsulae Gilbert, 1892, p. 548 (La Paz Bay, Gulf of Calif.), type in U.S.N.M., No. 44297, length 10.5 in.

Bascanichthys peninsulae Jordan and Evermann, 1896, p. 379 (descr. copied); 1900, pl. 63, fig. 166, 166a; Osburn and Nichols, 1916, p. 147 (name, Pichilinque Bay, Gulf of Calif., length 7.5 in.); Jordan, Evermann and Clark, 1930, p. 85 (name only).

Gilbert and Starks note that the dentition varies with age; that the smaller specimens have but two rows of jaw-teeth, while the larger have three or even four. Twelve specimens at hand, 145.5-675 mm. in length, clearly show this, and also that the granular teeth appear relatively higher in the smaller specimens. Clay impressions of the dentition of the type of *M. tigrinus*, of the smaller type of *Ophichthys xysturus*, undoubtedly conspecific, and of specimens at hand, demonstrate an added fact: in the smaller specimens, which include the type of *xysturus*, there is a space between the premaxillary teeth and the vomerines, which disappears as the eels reach larger size, including the type of *tigrinus* (see fig. 6, p. 81). Between 270 and 475 mm. this space may be more apparent than real, for close examination of specimens shows that sometimes there are rudimentary teeth too high on the arch to make good clay impressions; and also, that the sides of the upper lip may nearly meet behind the premaxillary teeth.

Gilbert and Starks also show that there is great variation within the species in the size and arrangement of the spots on head and body. Meek and Hildebrand note a variation in the number of rows of spots correlated with the size of the fish. My series shows this clearly; and also some variation in the size and arrangement of the spots, and even in the number of rows, in fishes of comparable size. Incidentally, my series shows that even the depth in length pro-

Table 2. Comparison of characters: a series of *Myrichthystigrinus* with the type of *Callechelys peninsulae*. Depth measurement for *C. peninsulae* is greatest depth, 10-15 mm. behind gill-opening. I have seen all specimens except the two types. Abbreviations explained in table 1, pp. 66 and 67, except Sn=snout. *=data from plate; **=data from original description; †=data from reexamination of type by Dr. Schultz, in 1938.

Specimen	Locality	Length	Characters: D in L	H in L	Tr in L	Tl in L	H in Tr	Tl in Tr	J in H	DO in H	Sn in H	GO Angle	Arrangement of Spots
3238-1	Mazatlan	675	27.85	11.25	3.0	1.75	3.75	.6	3.85	1.6	6.2	58°	4 rows, large; none on throat
M. tigrinus, type	Oregon	610**		12.0**								"vertical"**	4 rows; spots on throat**
3238-2	Mazatlan	590	24.5	11.8	3.0	1.7	3.95	.6	3.35	1.4	5.8	65°	3+ rows, smaller; none on throat
S-1	Gulf of Calif.	574	24.7	11.05	3.15	1.7	3.5	.55	3.45	1.6	6.05	65°	4 rows, smaller; spots on throat
4-A	Galapagos	473	27.4	10.55	3.05	1.75	3.45	.55	3.0	1.65	5.55	72°	3+ rows, smaller; spots on throat
6921-1	Panama	407	32.0	11.0	3.25	1.65	3.4	.5	3.65	1.6	5.7	67°	3 rows, large; spots on throat
6921-2	Panama	395	29.9	11.45	3.15	1.65	3.6	.5	3.4	1.55	5.45	76°	3 rows, large; spots on throat
3-A	Galapagos	296.5	30.55	11.4	3.2	1.65	3.55	.5	2.9	1.6	5.2	69°	2+ rows; none on throat
6921-3	Panama	275	30.6	10.75	3.25	1.65	3.3	.5	3.4	1.5	5.5	67°	2 rows; none on throat
6921-4	Panama	270.5	31.8	10.3	3.4	1.65	3.05	.5	3.3	1.6	5.25	61°	2+ rows; none on throat
B. pen. (type)	Gulf of Calif.	263†	37.6†	11.1†	3.3†	1.65†	3.35†	.5†	3.3†	1.65†	5.5**	73°* 48°†	2 rows; none on throat**
6921-5	Panama	253	33.3	11.0	3.3	1.65	3.35	.5	3.1	1.55	5.0	65°	2+ rows; none on throat
6921-6	Panama	165	33.0	10.85	3.3	1.65	3.3	.5	3.45	1.65	7.6	60°	2 rows; none on throat
Acad.-1	Pt. Parker	145.5	37.3	11.65	3.3	1.65	3.55	.5	3.65	1.55	5.0	65°	2 rows; none on throat
	MEAN	385.1	30.8	11.15	3.2	1.65	3.45	.5	3.35	1.6	5.7	65.85°	2-4 rows

Specimen	Locality	Length	D in L	H in L	Tr in L	Tl in L	H in Tr	Tl in Tr	J in H	DO in H	Sn in H	GO Angle	Arrangement of Spots

portion variations are only partially correlated with size (table 2, opposite).

From the description, the type of *Bascanichthys peninsulae* cannot be distinguished from specimens of *Myrichthys tigrinus* of similar size (see table 2), nor indeed, from the composite of the series (see fig. 6, below). Dr. Schultz compared the types for me, and reports the teeth to be almost identical in appearance. The impressions of the dentition which he sent me, sketched in figure 3, show the plan to be basically the same for the three types; any differences observable are due to the size of the specimen. I have no hesitation, therefore, in synonymizing *Bascanichthys peninsulae* with *Myrichthys tigrinus*.

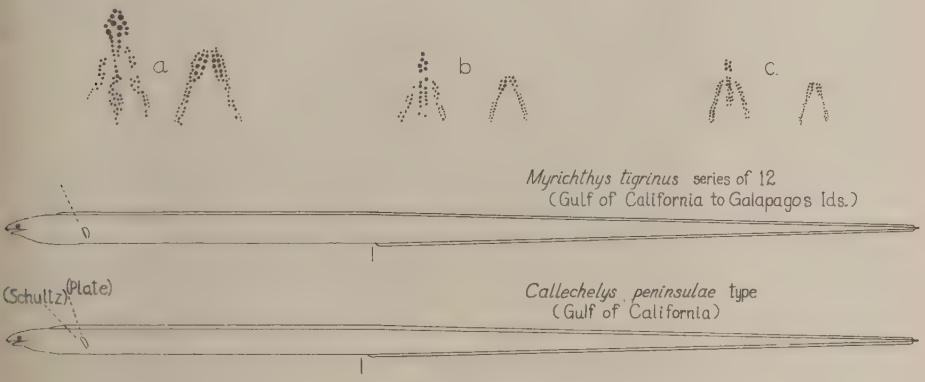

Fig. 6. The plan of dentition, sketched from clay impressions made by Dr. Schultz, of 3 U.S.N.M. types are shown above: a. *Myrichthys tigrinus*, No. 8810; b. *Ophichthys xysturus*, No. 28247; c. *Callechelys peninsulae*, No. 44296. Below: outline of c., compared with the composite outline of 12 specimens of *Myrichthys tigrinus*, scaled to 400 mm. length. See text and table 2, opposite.

Whitley (1934, p. 154) correctly asserts that *Bascanichthys hemizona* Ogilby (1897, p. 248) should be excluded from that "American genus," but it is obvious that the study of the genus by Australian authors has been confined to one species, *B. peninsulae*, now referred to *Myrichthys*. However, the developed pectoral alone would exclude Ogilby's fish from either genus.

The synonymization of *B. hemizona* with *Ophichthys pinguis* Günther (1872, p. 425; 1873, p. 430, pl. 35), first made by Waite (1901, p. 53), and since apparently accepted by Günther (1910, p. 399), McCulloch (1929, p. 71), and Whitley (above, and 1938, p. 195), is open to question on the basis of the original descriptions. I have seen neither type; but unless there are important errors in the original descriptions, of which I find no mention in succeeding accounts, I do not believe these species are even congeneric. Particularly, the position of the dorsal fin origin, the character of the teeth, and the plan of the dentition, need further investigation; and an ophichthyid eel with a depth in length proportion of 30.7 is hardly "elongate." The new genus *Malvoliophis*, proposed by Whitley in 1934 (above), may be justified, but from the available data, it does not seem that such a (combined) species should be referred to it.

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A POSSIBLE METHOD OF EVOLUTION OF ORAL BROODING HABITS IN CICHLID FISHES

By George S. Myers

Although considerable literature has accumulated on the oral brooding habits (commonly called mouth-breeding) of fishes, very few writers have concerned themselves with the origin of this remarkable method of caring for the eggs and young. The tenor of many of the papers is mere amazement at a fish hatching its eggs in its mouth and most of the remaining articles confine themselves to observations made on particular species.

The fresh-water percoid fishes of the family Cichlidae have perhaps received more attention than the other oral brooding forms. For some time it was believed that it was the male who cared for the eggs, but all of the egg-carrying individuals caught wild and examined afterwards by Boulenger (1) proved to be females. Following Boulenger, the statement that it is exclusively the female who broods the eggs in the African cichlids is frequently found in scientific textbooks and articles.

The strangest thing about this scientific literature on the oral brooding cichlids is that from it one would gather that all cichlids practice this peculiar breeding habit. Any aquarist who has bred any number of the many cichlids now available on the American aquarium fish market knows that this is not true. Of the large number of cichlids bred in recent years by aquarists, only a few species have hatched their eggs in the mouth (5). Most of the cichlids, both African and American, breed much like the North American sunfishes, with the following exceptions: the eggs are deposited on a stone instead of in a sand pit; both parents, instead of but one, care for the eggs and fry; and after the young are hatched they are transferred to a sand pit.

About fifteen years ago, when I was engaged in breeding various cichlids in aquaria, I began thinking of the possible origin of oral brooding. Since most fishes, even of those species that care for the eggs, frequently eat their own spawn with relish, the initial stages in the development of this peculiar habit seemed difficult to visualize.

At about that time I had in my aquaria examples of a cichlid currently sold as Acara bimaculata, the breeding habits of which were described by Leitholf (6). My own stock was obtained from Leitholf. I later discovered that the identification of the species was erroneous, but I am sorry to say that I never did find out even its proper genus. From the time my last specimens died (and unfortunately were not preserved) I have never seen any cichlid, alive or preserved, that closely resembles it—nor have I ever found anything just like it in the literature. Moreover, even the figure accompanying Leitholf's paper may be of another species. Several years later (7) I published a short article describing the habits of the fish and requesting information regarding it, but no replies were forthcoming.

This cichlid, which I spawned several times, differed in its habits from any others of which I have heard. The initial parts of the breeding habits were like those of other species excepting that no sand pits were dug. The eggs were deposited, over a period of an hour or more, on the top of a smooth stone, or, if no stone happened to be available, on one of the glass sides of the aquarium. Fanning the eggs with stiff, slow, unnatural, jerking movements of the pectoral fins then commenced, by one parent at a time. The "turn" of one fish lasted from one to perhaps three minutes. Whether the fanning was kept up all night or not I never certainly found out, but it continued into the evening until it was too dark to see the fish.

In forty-eight hours or so the eggs were ready to hatch and the parents began the ordinary cichlid habit of scraping the eggs off the stone with their teeth. But instead of carrying the now-hatched fry to a sand pit, as in all other species I have observed, each mouthful of young was ejected upon the bushy submerged roots of a floating aquatic plant, in this case Ceratopteris, the water fern. To these

roots the fry adhered, in a wriggling black mass. On close inspection it could be seen that each little fish was attached to the root by a filament a little longer than the fish itself The filament originated in the frontal region, being evidently a development of the cement organ, and the distal end was adhesive. The filament and its function were easily observed when one of the constantly wriggling larvae shook itself loose and was picked up in the mouth of a watchful parent to be expelled back towards the root.

I may digress at this point to mention that Budgett (4) found fish larvae with such a cement organ in the Gambia, and attributed them to a mormyrid. I think it much more likely that they were cichlids, as indeed Svensson (9) has lately suggested. Svensson identifies the parents as Tilapia melanopleura, a deep bodied cichlid very similar in form, but not in color, to the fish I had.

To return to our story—just as other cichlids transfer their young from one sand pit to another when disturbed (and sometimes when not), these fellows transferred their hanging brood in mouthfuls from root to root during the two days before the larvae could swim.

During one of the breedings of this cichlid I conceived the idea of testing out just how bravely the parents would protect their young against another fish. I introduced a large and particularly pugnacious Hemichromis bimaculatus male into the tank. It was just at the moment when the parents had about half their brood transferred from one root to another and each of the two adults had a mouthful of young.

Without waiting to blow the young in their mouths on a root, both parents set upon the Hemichromis furiously and for several minutes continued to attack it and chase it about the aquarium. I removed the unhappy intruder, upon which the parents quickly calmed and then immediately proceeded to the new root and shot out the unharmed young that they had held in their mouths during the whole encounter. I did not see a single crushed or injured larva, although it is possible that several were damaged.

On thinking this over, it seemed to me that I had witnessed what was probably the initial stage of oral brooding. If we can believe in natural selection, it is not difficult to visualize nesting cichlids, breeding among many enemies, being led (in the evolutionary sense) to retain the young for longer and longer periods until the brooding was acomplished entirely in the mouth.

But since both sexes take care of the young equally in the nesting cichlids so far studied, it seems remarkable that the female alone should have retained its parental solicitude in the oral brooders.

Evidence is now in our hands to show that it is not the female alone who has developed oral brooding instincts in the cichlids. The habit is not nearly as well fixed as the literature would lead us to suppose. Breder (2) has described a case in which a male Haplochromis multicolor, after a fight with the female, appropriated the eggs and brooded them himself. I have heard of other such cases in this species, from aquarist friends. Moreover, in a rather recently imported African cichlid, Tilapia microcephala, aquarists have found that it is the male who regularly broods the eggs. Another bit of evidence favoring this theory of habit development is that some of the oral brooders, at least, do dig a sand pit or depression in which the eggs are laid before they are taken into the mouth. One is strongly tempted to point this out as an undoubted reminiscence of the sand-digging habits of purely nesting ancestors.

In considering the whole subject of oral brooding in fishes it is interesting to note that in most of the families in which the habit is developed, there are both nesting and oral brooding species in the same family. In the Osteoglossidae we have the nesting Heterotis and the oral brooding Arapaima, Osteoglossum and Scleropages. In the Ariid catfishes all of the species of which the breeding is known have proved to be oral brooders save for the nesting Arius australis, described by Semon (8). Among the bubble nest building labyrinth fishes we find that Betta splendens, Macropodus, Osphronemus, Trichogaster, Trichopsis, and Colisa all make nests, but we now know two species, Betta picta and Betta brederi, that brood their eggs in the mouth. In these two, the breeding behavior, as reported by Breder, shows conclusive evidence of having developed from the normal nesting behavior of other species. Nothing else could account for the blowing-and-catching of the eggs, so reminiscent of the act of blowing the eggs up into the bubble nest, which is

no longer built by these two species.

In the cichlids, all the American forms of which the habits have been studied (save perhaps some species of Geophagus) are nest builders in one form or another. In Pterophyllum, a rock and a sand pit have given way to the broad leaf of an aquatic plant. Geophagus has been supposed since Hensel's time to be an oral brooder, but some species at least do not have this habit. The mere fact that an adult is caught with a mouthful of young is naturally no proof that the species is an oral brooder. The fish may merely have been transferring its young from one sand pit to another. Geophagus brasiliensis is a simple nesting species (5). In Africa Hemichromis bimaculatus, at least, is a true nesting species. Many others probably also nest, but most of the African forms so far reported are oral brooders.

In all of the nesting fishes of the groups that have produced oral brooding species, the nesting activities demand the taking of the eggs into the mouth at some time, usually directly after deposition. I, at least, am fully convinced that this is the germ from from which the highly specialized habit of oral brooding has arisen. The basic habit of taking the eggs into the mouth for any purpose other than eating them is much more difficult to account for, and I do not venture to speculate on its origin.

[This paper was read before the May, 1934 meeting of the American Society of Ichthyologists and Herpetologists in New York City, in practically its present form. Among those present was Mr. C. M. Breder, Jr., Assistant Director of the New York Aquarium, whose paper on the breeding habits of Aequidens (3) was at that moment in press. Although neither of us knew of the other's results when our papers were written, I am happy to say that we found ourselves to be in essential agreement in regard to the origin of oral brooding in the cichlids.]

References.—(1) Boulenger, 1906, Trans. Zool. Soc. London, vol. 17, p. 537; (2) Breder, 1918, Aquatic Life, vol. 3, p. 141; (3) Breder, 1934, Zoologica, vol. 18, no. 1; (4) Budgett, 1901, Trans. Zool. Soc. London, vol. 16, p. 131; (5) Innes, 1935, Exotic Aquarium Fishes; (6) Leitholf, 1918, Aquatic Life, vol. 3, p. 153; (7) Myers, 1926, Aquatic Life, vol. 10, p. 60; (8) Semon, 1899, In the Australian Bush; (9) Svensson, 1933, Kungl. Svenska Vetenskapsak. Handlingar, Ser. 3, vol. 12, no. 3, p. 92.

NOTES ON THE LABRID GENUS *LIENARDELLA*

By George S. Myers

The essential homogeneity of the great Indo-Pacific fish fauna is occasionally brought out in a striking manner, such as the discovery of the Riu Kiu goby *Amblygobius naraharae* Snyder in the Marquesas by Dr. Herre (Notes on fishes in the Zool. Mus. Stanford Univ., I, 1934, p. 7), or the description of *Kraemeria samoense* Steindachner (under three generic and three specific names) from the Seychelles and Samoa.

I now wish to call attention to the wide range of another fish, described and figured by Snyder (Proc. U.S. Nat. Mus., vol. 35, 1909, p. 96; and vol. 42, 1912, pl. 66, fig. 1) from Okinawa, Riu Kiu Islands, as *Lepidaplois mirabilis*. Several years ago the colored plate of *Xiphochilus fasciatus* Günther (Proc. Zool. Soc. London, 1867, p. 101, pl. 10), described from two dried specimens in the British Museum from Cape York, Queensland, attracted my attention by its similarity to the fine figure of Snyder's fish. I have lately been able to compare Snyder's type (U.S.N.M. 62234) with Günther's description and figure. When we consider that Günther described his fish from dried specimens, probably not in the best of condition, I do not think that much doubt can be entertained regarding the identity of the two nominal species. The rounded tail and the absence of

the basal sheath of scales on the soft dorsal in Günther's examples are doubtless due to the method of preservation.

The generic position of the species presents some difficulty. Fowler and Bean (Bull. U.S. Nat. Mus., no. 100, vol. 7, 1928, p. 202) describe the new subgenus *Lienardella* for *mirabilis*, distinguishing it chiefly by the deep head and the color. The species certainly has nothing to do with *Xiphocheilus typus* of Bleeker. After the examination of various species of *Lepidaplois* I am inclined to recognize Fowler and Bean's name as of generic rank. *Lienardella fasciata* differs from *Lepidaplois* particularly in the broadly united, unnotched gill membranes (deeply notched medially in *Lepidaplois*) and in the deep blunt head. The species should be looked for throughout the East Indies as it is doubtless widely spread from China and the Riu Kius to Queensland.

ON THE BRAZILIAN CHARACID FISH *NOTROPOCHARAX DIFFICILIS* MARINI, NICHOLS AND LA MONTE

By George S. Myers

Some time ago I had the opportunity of examining the holotype of *Notropocharax difficilis* Marini, Nichols and La Monte (Amer. Mus. Novit., no. 618, 1933, p. 6, fig. 3; Rio Mogy-guassú, S. E. Brazil), through the courtesy of Mr. J. T. Nichols. I find that the anterior half of the maxillary is toothed, with apparently conical teeth; premaxillary and dentary teeth in a single series, rather slender and tricuspid, with the middle cusp high, and somewhat hooked inward. The great suborbital entirely covers the cheek; above it there is a large postorbital about the size of the eye, and above this two very tiny postorbitals on the right side of the fish, but only a single one on the left. Added to the characters given in the original description, these data enable us to place the genus *Notropocharax* as a synonym of *Aphyocharax*, and the species *Aphyocharax difficilis* as an extremely close relative of *A. dentatus* Eigenmann and Kennedy (see Eigenmann, Mem. Carnegie Mus., vol. 7, 1915, p. 25). It is to be noted that the Rio Mogy-guassú is an eastern tributary of the Rio Paraná.

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